

U. S. DEPARTMENT OF COMMERCE

TECHNICAL NEWS BULLETIN

OF THE BUREAU OF STANDARDS

ISSUED MONTHLY

JUL 7 1931

Washington, June, 1931.—No. 170

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TWENTY-FOURTH NATIONAL CONFERENCE ON WEIGHTS AND MEASURES

The Twenty-Fourth National Conference on Weights and Measures, which met at the bureau on June 2 to 5, was attended by weights and measures officials representing 25 States and the District of Columbia, representatives of scale and pump manufacturers, railroads, and industry. The conference considered and took action on a wide variety of matters directly affecting the buyers and sellers of commodities and services.

The "penny-in-the-slot" scale may not ordinarily be thought of as a device for the selling of service, yet such a scale does represent itself as prepared to render a weighing service for a consideration, and as such it becomes subject to official regulation. One of the actions taken by the conference was the proposal of a code of regulations for these person-weighing scales. Whether the scale passes out a ticket with a weight stamped upon it or whether the customer reads his weight from a chart, the code will require the same clearness and definiteness of the indications and will impose the same restrictions as to permissible errors as in the case of commercial scales used in the weighing of commodities.

Among other subjects considered were a special equipment for the testing of large-capacity oil meters, several forms of trucks carrying from 7,000 to 16,000 pounds of test weights in units of 500 or 1,000 pounds, special scales installed on the highways for determining the actual load on each wheel of a loaded truck so as to prevent overloading and consequent damage to the highways, and various types of gages and gaging utilized in industry to control manufacturing processes.

A number of officials of the Federal Government addressed the meetings. R. S. Regar, of the Post Office Department, announced a 4-year program of his department for the testing, adjustment, and replacement of scales used in the weighing of the mails, in which connection it was stated that "scales are the most important item of supply and equipment in the entire postal service," and that it is apparent that "corrective measures must be taken immediately to protect the revenues of the Government and the interests of the public." The conference was asked by H. A. Spillman, of the United States Department of Agriculture, to consider a proposed bill designed to effect a consolidation of existing Federal legislation relative to baskets, hampers, and barrels for fruits and vegetables,

and to correct certain faults which have been found to exist in these laws, particularly interference with State statutes demanding sale of dry commodities by weight. A recent amendment to the Federal food and drugs act was discussed by Dr. W. S. Frisbie, also of the Department of Agriculture; under the new law canned fruits, vegetables, and fish will be considered standard if they conform to a certain standard of quality and fill, otherwise they must be labeled as substandard.¹ Dr. Frisbie pointed out that both grades of products will, of course, be required to be entirely wholesome and pure under the general provisions of the food and drugs act. F. S. Holbrook, of the National Bureau of Standards, spoke upon the status of standard-weight legislation for bread; several State laws requiring standard-weight loaves have recently been attacked in the courts by the bakers.

Numerous features of the work of the National Bureau of Standards were discussed by Dr. George K. Burgess, Director of the Bureau and president of the conference, who emphasized the diversity and amount of the bureau's testing work. Hon. Charles West, Member of Congress from the Seventeenth Ohio District, urged that a proper balance be maintained between Federal and State regulation along weights and measures lines, so that on the one hand interstate commerce might be safeguarded and on the other hand there might be a minimum of encroachment on the rights of the States to regulate their own internal commercial affairs. The methods of weights and measures control in Canada, where the entire service is maintained by the central government of the Dominion, was described to the conference and contrasted with the system followed in the United States, by D. J. McLean, superintendent of the Canadian Weights and Measures Inspection Service.

Other speakers included H. S. Jarrett, of Charleston, W. Va., who discussed the marking of all package goods with statements of their net con-

tents; W. O. Williams, of Girard, Ohio, who urged the rigid inspection and testing of all person-weighting scales; A. Bousfield, of St. Johnsbury, Vt., who traced the development of large-capacity scales over the past 50 years; M. J. J. Harrison, of Chicago, Ill., who discussed, with particular reference to coal weights, the factors involved in large-capacity weighing; De Forest McLin, of Huntington, Ind., who extended a warning against the activities of incompetent, so-called scale mechanics who prey upon scale owners, particularly in the smaller towns; and C. L. Richard, of Chicago, Ill., who told the conference of the activities of the National Scale Men's Association, an organization having many interests in common with the conference.

The conference revised a previously adopted code of regulations for glass bottles used at retail filling stations for dispensing lubricating oil for automobile crank case use. Certain oil distributors wanted the conference to exempt from the requirements of the code all bottles intended to be marketed as sealed containers, but while the former code was liberalized in some respects, notably by permitting a popular type of tall, small-diameter bottle, it failed to accede to the request for the exemption of sealed bottles, and recommended that both sealed and unsealed bottles be required to have a capacity line and a statement of their capacity blown in the bottle.

A code of regulations for mileage-recording instruments known as odometers was finally adopted, having been tentatively adopted a year ago. It was recommended that after January 1, 1932, new measuring devices for grease and transmission oil be required to be so designed that whenever the supply of lubricant is exhausted the device will become inoperable as a conspicuous warning will be given that the device is in need of refilling.

The various codes of regulations adopted by the conference do not become effective in most States solely by reason of the conference actions; usually it is not until these codes are promulgated by the State officials, under statutory authority, that their provisions become mandatory. In some States, however, adoption of a code of specifications and tolerances by the conference either automatically or indirectly results in putting such a code into effect.

In connection with the consideration of scale subjects there were exhibited by their manufacturers various scales embodying new features of design and

¹The form of label prescribed by the Secretary of Agriculture for canned foods of substandard quality is as follows:

**BELOW U. S. STANDARD
LOW QUALITY BUT NOT ILLEGAL**

It will be understood that cans not so labeled contain foods which are in compliance with the "standard" requirements for quality as defined by the Secretary of Agriculture, and that the contents of the cans occupy 90 per cent or more of the volume of the can.

a number of the latest types of person-weighing scales. By resolution, the conference requested manufacturers of small scales to provide special facilities for placing the official seal of approval in a uniform position, so that the customers in retail stores may be the better able to tell when such scales have been approved by the weights and measures officer.

Dr. George K. Burgess was reelected president of the conference. Other officers elected were Albert B. Smith, of Harrisburg, Pa., first vice president; I. L. Miller, of Indianapolis, Ind., second vice president; F. S. Holbrook, of the National Bureau of Standards, secretary; and George F. Austin, Jr., of Detroit, Mich., treasurer. An executive committee, consisting of the officers and of an official from each of 20 States, was also elected. The next meeting of the conference will be held in Washington, D. C., in June, 1932.

METALLURGICAL ADVISORY COMMITTEE

Scientific research work is well recognized as a form of investment upon which dividends, commensurate at least with the investment made, are naturally to be expected. Research work carried out in Government laboratories, like that supported by industry, should give adequate returns on the investment.

In order that the metallurgical research work of the bureau may be well planned and efficiently directed along lines which show promise of value and usefulness to the metallurgical industry, an advisory committee was organized a number of years ago. The annual meeting of this committee was held at the bureau on May 19 and 20.

This committee, though strictly unofficial, is believed to be representative of the metallurgical industry. The members have been designated by the various national technical societies, among whom are: The American Society for Testing Materials (7); the American Society for Steel Treating (2); the American Foundrymen's Association (3); American Institute of Mining and Metallurgical Engineers, iron and steel division (2); American Association of Steel Manufacturers (2); Society of Automotive Engineers (1); American Institute of Mining and Metallurgical Engineers, institute of metals division (8); American Society of Mechanical Engineers (1); American Electrochemical Society (2); American Chemical Society (1); and National Research Council (1).

The ferrous and the nonferrous branches consist of 20 members each. In addition, a number of invited guests are included for each meeting whose advice on certain specific problems under way is desired.

Among the current research projects reported upon and discussed at the meetings a few may be mentioned as typical; these are: Studies of defective steel bridge wire, characteristics of rail steel as related to the formation of transverse fissures, the phenomenon of magnetism in iron as related to atomic structure, the preparation and properties of pure iron, the properties of molten metals affecting their casting properties, thermal conductivity of metals, the general problem of the wear of metals, fundamentals involved in the machining of metals, the creep of metals under load at high temperatures, and various aspects of the corrosion of metals.

The committee is entirely advisory in its scope and while definite recommendations are occasionally made, its greatest value lies in its wholesome influence which has been repeatedly demonstrated during the 18 years which it has been in existence.

PAPER FROM HIGHLY PURIFIED WOOD FIBERS

The bureau has been studying on a semicommercial scale the manufacture of bond types of papers from commercial highly purified wood fibers. The papers are suitable where strength and permanency are desired. The object of the work was to determine the quality of paper which can be made from such fibers under favorable conditions, how to obtain this quality, and the extent to which variables commonly encountered in the papermaking process affect the quality of papers made from this type of fiber.

The first phase of the study was concerned with the development of a beating procedure designed to produce papers having the highest possible strength consistent with the other qualities required in saleable commercial papers. By studying the effects of variations in beating conditions on the properties of the papers produced, a method of beating the fibers was evolved which gave the desired results. Since the highly purified wood fibers hydrated comparatively slowly, it was possible by gradual lowering of the beater roll to avoid the excessive hydration which makes for hardness, low opacity, and low tearing strength, and yet accomplish the fibrillation and fraying out necessary to impart good

felting properties to the fibers, so as to obtain the high strength and other properties characteristic of the bond type of paper. Photomicrographs of the beaten fibers show clearly that they are well fibrillated. The papers had excellent strength properties, exceeding, in the case of the bond papers, the strength requirements of the high-

est grade bond papers purchased by the Government Printing Office, and, in the case of the currency type papers, the strength requirements for United States currency. In the following table, characteristic test data for some of the papers prepared from these fibers are given:

Test data for experimental paper produced from high purified wood fiber

Weight, thickness, and strength	Kind of paper				
	Unsize	Bond, sized in the beater with 2 per cent rosin	Bond, sized in the beater with 1 per cent rosin and 5 per cent starch	Bond, sized in the beater with $\frac{1}{2}$ per cent rosin and surface sized with glue	Currency, surface sized with glue, no beater sizing
Weight, 25 by 40, 500 sheets.....pounds..	57.2	56.2	56.9	57.9	62.6
Thickness.....inches.....	.0040	.0039	.0037	.0037	.0038
Bursting strength.....points.....	45.0	36.5	49.5	53.1	63.2
Folding endurance, double:					
Machine.....folds.....	3,400	3,660	5,730	3,510	3,960
Cross.....do.....	4,380	3,290	4,270	4,320	5,400
Tensile breaking strength:					
Machine.....kilograms.....	9.3	9.0	10.9	10.4	-----
Cross.....do.....	6.1	5.4	6.6	7.1	-----
Tearing strength:					
Machine.....grams.....	103.2	86.0	98.4	85.0	80.8
Cross.....do.....	107.6	103.2	110.4	90.2	84.8

NOTE.—These data were obtained in atmospheric conditions of 65 per cent relative humidity and 70° F. temperature. A report containing complete details of this research is being prepared.

DISCOLORATION OF PAPER BY ROSIN

The bureau, as a part of extensive researches on the preservation of written and printed records, has obtained additional information on the relation of rosin to the yellowing of paper with age. Rosin is employed in record papers as one of the sizing agents necessary for the use of aqueous writing fluids.

The discoloring effect of light upon rosin, and compounds of rosin formed during the rosin sizing of paper was studied, both in air and in an atmosphere of nitrogen, a relatively inert gas. The source of light used was an inclosed carbon arc. The various grades of commercial rosin used in paper; bleached rosin; resinates of sodium, aluminum, and iron; and rosin size contaminated with ferrous and ferric iron, were exposed to the rays of the arc in sealed quartz tubes. The bleached rosin was included because of a patented bleaching process claimed to prevent discoloration of the rosin by light.

The resinates were darkened by the light, even in the inert atmosphere of

nitrogen. The bleached rosin darkened to about the same extent as the unbleached. The ferrous resinate was also light sensitive, and an intimate mixture of ferrous resinate and rosin, as found in rosin size contaminated with quantities of ferrous iron smaller than those usually found in industrial waters, was more sensitive to light than rosin alone. The color change of ferrous resinate is probably the result of a photochemical reaction. The ferric resinate, aluminum resinate, and sodium resinate were not light sensitive.

The complete details of this study were published in the May, 1931, issue of the BUREAU OF STANDARDS JOURNAL OF RESEARCH, as Research Paper No. 307, The Light Sensitivity of Rosin Paper-Sizing Materials, by Kimberly and Hicks.

Since rosin-sized paper contains rosin, ferrous resinate, and rosin size contaminated with ferrous iron, all of which were found to be light sensitive, rosin sizing as currently practiced appears to be detrimental to the preservation of the color of record papers. An attempt will be made to obtain

further information on the extent and nature of the effect of rosin sizing materials on the aging properties of papers by studies of papers to be made in the bureau's mill containing known amounts and kinds of such sizing materials.

FASTNESS TO LIGHT OF DYED TEXTILES

The bureau has been cooperating with the American Association of Textile Chemists and Colorists for over seven years in the development of standard methods for testing the fastness to light of dyed textiles. Six papers on different phases of this work have been published. A seventh, entitled "Classification of the Fastness of Dyed Textiles in the Standard Sunlight Exposure Test," by William H. Cady, William C. Smith, and William D. Appel, will appear in an early issue of the American Dyestuffs Reporter.

In this paper is given the relative fastness to light of 1,197 cotton, wool, silk, and weighted silk dyeings, representing 366 dyestuffs when exposed to sunlight in the standard "sun test" of the association. Tables showing the classification of the dyeings into seven fastness classes and an exposition of the method of classification are given.

Briefly, the dyeings were exposed at an angle of 45° from the horizontal facing south between 9 a. m. and 3 p. m. on sunny days only, in cabinets covered with a good grade of window glass approximately one-eighth inch thick and open at the sides in such a way as to allow free access of air to the samples. The distance between the samples and the glass was one-half inch.

Each sample was exposed for four different periods of time, each period being double that of the next shorter period. The most fugitive samples were exposed for 6, 12, 24, and 48 hours. Depending on the fastness of the color, other samples were exposed for longer periods of time up to 768 hours.

The samples were then classified. Dyeings which showed an appreciable alteration in color when exposed for 6 hours were assigned to the lowest class, class 0. Dyeings which showed little or no alteration in color when exposed for 6 hours, but which showed an appreciable alteration in 12 hours, were assigned to class 1. Other dyeings were assigned to classes 2 to 6 on a similar general basis. In order to eliminate the uncertainty inherent in the terms "appreciable" and

"little," dyeings were selected to represent the minimum requirements for classes 1 to 6. The use of these standards of fastness made it possible to take into account the changes in color of dyeings in the longer exposures, changes which can not be adequately described in the classification scheme, outlined above. The choice of standards for general use is an important outcome of the work that is receiving further attention.

The paper should be of special interest to producers and users of dyeings. It is expected that the classification will be of greatest service to those who are already familiar with the utility of some of the dyes for their specific purposes.

CARPET-WEAR TESTING MACHINE

A machine for testing the resistance to wear of carpets and similar floor coverings, when they are subjected to definite wearing forces under controlled conditions, has been developed. The forces are chosen to produce the bending, slipping, twisting, and compression of the pile which takes place when a carpet is walked upon.

A circular sample of the carpet is tacked on a turntable which is brought to bear against two leather-covered wheels. One of the wheels is driven by a motor and in turn drives the turntable. The other wheel is used as a brake to produce slipping of both wheels on the carpet as it rotates. A vacuum cleaner removes the material which is worn off. The wear on the carpet is produced by a downward force, a horizontal stress, and a slight twisting motion, all of which have definite values and may be changed if desired. The rate of wear is determined by measuring the change in thickness of the pile of the carpet with a sensitive thickness gage.

The machine can be used to test the relative durability of carpets under definitely specified conditions. Whether the results are a satisfactory measure of probable relative durability of carpets in service has not been determined. The machine should be useful for studies of the effect of various factors on carpet wear and for studies of the relation between the composition and construction of carpets and their resistance to wear.

This machine will be described and some of the results obtained with it discussed in the June issue of the BUREAU OF STANDARDS JOURNAL OF RESEARCH.

THICKNESS GAGE FOR FABRICS

A gage has been developed for measuring the thickness of carpets during tests on the carpet wear testing machine. It is believed that the gage will be found suitable for measuring the thickness of other fabrics, since it provides a ready means of measuring thickness under an extremely small known load and under a series of different loads. Thus a measure of the softness or hardness of the fabric can be obtained. The recovery after the application of a load for any period of time can also be determined readily with this gage and thus the "compressive elasticity" can be evaluated.

The gage consists of a delicately balanced arm, on one end of which can be placed a foot of any desired cross-sectional end area of contact. By placing weights on the foot the load on the fabric can be adjusted to suit conditions. The support of the knife-edge on which the arm rests can be raised or lowered by means of a micrometer screw. This movement is indicated on a dial which is graduated in thousandths of an inch. The difference in reading obtained when the foot is lowered onto a fabric till the arm just balances and a similar reading obtained with the fabric removed gives the thickness of the fabric.

An illustrated description of this device is included in the paper on the carpet wear testing machine which will appear in the June issue of the BUREAU OF STANDARDS JOURNAL OF RESEARCH.

Recently a pressure gage has been designed to be used with the thickness tester. By using this gage the thickness can be read directly for any pressure on the fabric from zero to a given maximum. The pressure on the fabric is indicated on a dial, over which moves an indicator actuated by the balance arm of the thickness gage.

CAMERA FOR PHOTOGRAPHING BULLETS

The special camera, developed some time ago by Raymond Davis, of the bureau, for photographing the surface of specimens of pipe, has been adapted to the photographing of the complete surface of bullets or other small cylindrical objects in a single picture. These are photographed at a magnification of 10 diameters. This has been made possible by the use of a short focus motion-picture lens in conjunction with suitable pulleys so that the speed of the film is now ten times the surface speed of the bullet. The bul-

lets are mounted on the ends of brass rods with wax. A mounting arrangement is provided, whereby the axis of the bullet is brought into line with that of the rod. Pulleys of suitable diameters are provided so that all of the common-caliber bullets may be accommodated.

COLOR CORRECTION OF MICROSCOPE LENS SYSTEMS

In a paper which will appear in the June number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH methods are described for the measurement of the lateral chromatic aberration and distortion of microscope objectives and eyepieces. Measurements have been made on 20 apochromatic microscope objectives of four different makes, and on 10 compensating eyepieces of two makes. The results show that the compensating eyepieces, in general, do not entirely compensate for the chromatic aberration of the objectives, and that the complete microscope system is usually undercorrected. The bearing of this on the performance of the system in photomicrographic work by a 3-color process and in the direct visual observation of objects is considered in detail.

WALDNER-BURGESS STANDARD OF LIGHT

The successful setting up in the laboratory of the Waldner-Burgess absolute standard of light was described in Technical News Bulletin No. 151, p. 107 (November, 1929). A paper, which will appear in the June number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH, describes the results of experiments in the development of this accurately reproducible light standard. The source of light used is the open end of a small tube closed at the other end and maintained at a definite high temperature. The amount of light emitted from the interior of the tube through the open end is not affected by the material of which the tube is made, but depends only on the temperature. The tube actually used was composed of thorium oxide, a very refractory material, and was kept at a definite and reproducible high temperature by immersing it, closed end down, in a crucible of molten platinum. When the platinum begins to solidify, the immersed tube is at a definite temperature 1,774° C. (3,224° F.) and remains at this point as long as any liquid platinum is left. The brightness of this source was compared, using a photometer, with the standard electric lamps of the bureau. Many comparisons were made,

and it was found that the proposed standard was accurately reproducible. The actual intensity of light from a square centimeter of this source was found to be 58.84 candles.

EXTREME ULTRA-VIOLET SOLAR RADIATION

A subject widely discussed to-day is the use for therapeutic purposes of the short wave length ultra-violet rays in sunlight and in arc lamps, recognized by biologists as possessing healing value, especially in the treatment of rickets.

It has been found that common window glass shuts out some wave lengths of sunlight that have the property of preventing rickets. Spectrum analysis shows that the constituent shut out by window glass consists of the shortest ultra-violet wave lengths in sunlight. This constituent or component of the total incident sunlight is greatly reduced by the presence of smoke, dust, etc.

A paper which will be published in the BUREAU OF STANDARDS JOURNAL OF RESEARCH for June gives data on the variation of the ultra-violet in sunlight, useful for healing purposes, as affected by atmospheric pollution (smoke, etc.), altitude of the station (Washington, D. C., and Flagstaff, Ariz.), humidity of the air, time of the day, and season of the year.

RELATION BETWEEN COMPOSITION AND INDEX OF REFRACTION OF GLASS

A study of the relation between composition and index of refraction of glass was started some time ago at the bureau, and the first phase of this work has been tentatively completed and will be described in the June number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH. Many glasses were made, containing soda, lime, and silica in various proportions.

The glasses were melted in platinum crucibles placed in a specially constructed furnace which was heated by a controlled current flowing through a platinum-rhodium spiral.

After measuring the index of refraction of 42 of these glasses and making chemical analyses of each of them, an intensive study was made of the data obtained. Finally, a series of curves was drawn from which it is possible to read the index of refraction of any glass of the soda-lime-silica group in the range studied and also to predict the compositions of the numerous glasses having the same index of refraction.

Such work is of particular interest to the manufacturer of optical glass because it indicates the changes that must be made in the composition of a glass to produce a desired change in index of refraction. It should also be useful to the manufacturer of other kinds of glass, such as window glass, as a quick and reliable method of detecting changes in the composition of the glass he is making.

PHYSICAL PROPERTIES OF SLATE

A tabulation of physical test data on slate, covering samples tested at this bureau during the past 10 years, is being made for a publication which will probably be issued this year.

Data are available on 338 samples from 12 districts as follows: Nine from Maine; 35 from the New York-Vermont area; 30 from the hard-vein district of Pennsylvania; 56 from the Bangor district of Pennsylvania; 124 from Pen Argyl, Pa.; 11 from Wind Gap, Pa.; 15 from Slatington, Pa.; 28 from Virginia; 4 from Maryland; 4 from Arkansas; and 1 each from Tennessee and Georgia.

Strength in flexure has been determined mainly across the grain on specimens in the dry state. The values of the modulus of rupture vary from 4,000 to 16,500 lbs./in.² An average of 1,287 tests regardless of grain direction for fresh slate gave a value of 10,400 lbs./in.² A comparison of 174 flexural strength determinations, in which half of the specimens were broken across the grain and the others along the grain, indicates that the material is only about 65 per cent as strong when broken in the grain direction. However, there appears to be a considerable variation in this relation for slates from different districts, some being almost as strong in one direction as the other, while others are less than half as strong in the grain direction as perpendicular to it.

Elasticity determinations have been made on 220 samples and the average of 550 individual tests gave a modulus value, $E=13,250,000$.

The maximum bend of a slate three-sixteenths inch thick, when supported along two lines 16 inches apart and loaded at the mid-point to failure, has been considered as a measure of the toughness. This is computed from the modulus of rupture and modulus of elasticity values, and the average of 299 tests across the grain on dry specimens gives a value of 0.186 inch. The range in toughness values was from 0.090 to 0.263 inch.

Absorption values show a range of from 0.01 to slightly over 1 per cent on freshly quarried slate, with an average for 1,287 tests of 0.26 per cent.

Values for the apparent specific gravity of the slates range from 2.74 to 2.89, which correspond to unit weights of 171 to 181 pounds per cubic foot for slate in the dry condition.

Attempts to determine the porosity of slate have not been satisfactory, apparently because of difficulties in getting accurate values for the true specific gravity. Absorption tests indicate apparent porosity values ranging from 0.03 to 2.8 per cent.

Weathering tests have embraced freezing and thawing, soaking and drying, and acid tests. The freezing tests have indicated that frost plays only a minor part in slate weathering, as 2,000 cycles of the freezing test usually do not show more than a thin scaling of the surface layers. Soaking and drying tests produce decay similar to that found in actual weathering, and 40 or 50 cycles produce measurable strength losses or complete decay of the less resistant slates. Seven days immersion of slate in a 1 per cent H_2SO_4 bath seems to offer a convenient means of discrimination between the better and poorer weathering slates.

THERMAL EXPANSION OF KAOLIN

The bureau has been making a study of the linear thermal expansion of five kaolins obtained from some of the more important world sources. The expansion has been measured after firing each of these clays at six different temperatures ranging from 1,150° to 1,500° C. It was found that two of these kaolins have a decided increase in the rate of expansion between 100° and 200° C. which is practically absent in the other three. Although it has long been assumed that this increased rate of expansion below 200° C. is caused by the inversion of one form of cristobalite to another, no definite evidence has ever been presented to establish that assumption as a fact. The petrographic microscope has failed to identify the cristobalite as such because of its finely divided state and because it is present as an interstitial material. X-ray diffraction patterns were recently made of one kaolin which did not show a high rate of expansion between 100° and 200° C., as well as of one which showed the increased rate. In the first case only the typical mullite pattern was observed, whereas in the second case the diffraction patterns of both cristobalite and mullite were clearly visible. This information,

therefore, definitely establishes the fact that the increased rate of expansion between 100° and 200° C. in clay bodies is primarily caused by the presence of cristobalite.

GASES EVOLVED BY FELDSPARS

The preliminary phase of an investigation of the nature and amounts of gases evolved by feldspars, when heated, has been completed recently at the Columbus station. Nineteen feldspars were investigated, the samples having been chosen as representative of the ground material used in the ceramic industry.

At 1,000° C. the gases were found to consist by weight of from 31 to 87 per cent water and, with the exception of two feldspars, the water made up over half of the adsorbed gas. The acid gases (CO_2 , SO_2 , Cl , etc.) varied from 0 to 58 per cent and other gases (not determined) made up the remainder, from 3 to 34 per cent. Five samples were tested to determine the CO and H_2 evolved; the latter gas was not detected, but the former varied from 0 to 0.10 per cent of the sample (weight basis). The water and "acid gases" (average of 19 samples) evolved were, respectively, 0.28 and 0.07 per cent.

Volume calculations, based on the weight determinations, furnish more striking comparisons. In these calculations it was assumed that water vapor acts as a perfect gas at temperatures above 400° C., and that the "acid gases" are composed entirely of CO_2 . The resulting values are approximate, and the following volumes were obtained from a 10 g sample of Feldspar No. 8: Up to 400° C., 44 ml of water vapor and a fraction of a milliliter of acid gas is given off. From 400° C. to 800° C., an average of 25 ml of water vapor is given off for each 100° interval, and the CO_2 gradually increases to 14 ml for the interval 700° to 800°. Above 800° C., the evolution of water decreases, CO_2 practically ceases, but CO increases to 26 ml for the 1,100° to 1,200° interval.

The following are the extremes at 1,000° C., the volumes of gases being calculated to 1 cc of solid sample:

Water vapor	mi
CO	16 to 140
	0 to 15

SPECIAL REFRACTORIES FOR USE AT HIGH TEMPERATURES

In the determination of the physical properties of a pure metal it is usually necessary to melt the metal in order to secure suitable specimens.

It is highly desirable that no impurities be introduced into the metal from the crucibles in which it is melted. Crucibles of special oxides or of unusual purity, refractories which are not commercially obtainable, are frequently required. Then, too, with the use of the modern electric furnaces, temperatures up to 2,000° C. and over are readily obtainable and are more and more frequently used. The refractories ordinarily employed in the commercial melting of metals are not suitable for the melting of very pure metals at these higher temperatures. In the oxides of zirconium, magnesium, thorium, and beryllium there are available refractories which have been used for the melting of metals at temperatures up to 2,200° C. (4,000° F.) without contamination of the metal by the refractory.

A paper in the June number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH describes methods for the preparation from these refractory materials of various shapes that are used for the laboratory melting of very pure metals. The refractory oxide mixed with a suitable bonding material is tamped, pressed, or otherwise formed to the required shape and then fired at a temperature which should be somewhat higher than that at which it is subsequently to be used, in order to minimize further sintering and shrinkage in service. Refractory shapes made from previously fused oxides do not shrink appreciably in use.

A sample of pure platinum contained in a crucible of fused thorium oxide was melted and frozen more than 150 times in the course of a determination of its melting point without loss of any of the metal by leakage through the crucible. The purity of the platinum was practically the same after all these melts as at the beginning.

The method used for fusing the thorium oxide, which has a melting point above 3,000° C., is described.

FREEZING POINT OF PLATINUM

It is well known that the freezing of a pure material takes place at a constant temperature, the most familiar instance being the freezing of water at 0° C. Pure metals also have definite freezing points, which are useful in accurate temperature measurements. One of the more important freezing points is that of platinum, somewhat above 1,770° C. In spite of the importance of the platinum freezing point, various determinations of its temperature, even those made in recent years, have differed by nearly

10° C. The bureau has recently made another determination of this freezing point and found it to be 1,773.5° C. (3,224° F.), which is believed to be correct within about 1° C.

The platinum is melted in a small crucible, in the middle of which is a tube, less than one-eighth inch in diameter, immersed in the melted platinum. The light coming from this tube, not that from the platinum itself, is observed with an optical pyrometer. In making an observation, the platinum is melted, and the liquid heated somewhat above its melting point, and is then allowed to cool slowly. The observer notices that the brightness decreases slowly until freezing begins, when the brightness does not change for several minutes. After freezing is completed the brightness again decreases.

Even a few years ago the measurements described would not have been possible. It was necessary to prepare crucibles of thorium oxide in which the platinum could be melted without contamination by the crucible material. Melting was done in an induction furnace which operates so as to cause a heavy electric current to flow in the platinum itself without using any connecting wires, and nothing is heated except the platinum and the crucible containing it. A very accurate optical pyrometer designed at the bureau was used. Since only a small specimen of platinum is needed the value of the metal was not over \$200. One ingot was melted nearly 100 times, and many hundreds of observations were made of the temperature of freezing. Much care and numerous observations were necessary to obtain a result which might be considered reliable within a few degrees.

This work will be more fully described in the June number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH.

METHODS FOR CLASSIFYING WEAR OF METALS

Wear of metals and methods for classifying it will be discussed by Louis Jordan of the National Bureau of Standards in the August number of Mechanical Engineering, published by the American Society of Mechanical Engineers.

Wear of a metal is the unintentional removal in service of the surface of a metal through the action of frictional forces. The different types of metallic wear have been classified as metal against metal and metal against non-metal, or as wear under rolling fric-

tion and wear under sliding friction. A more logical classification is on the basis of the physical and chemical actions at the surface of wearing metals, namely, wear by abrasion, in which the wear is caused entirely by mechanical roughening and rubbing off of the metal surface; wear by erosion, in which a chemical attack of the metal surface first takes place, followed by mechanical rubbing of the products of the chemical attack; and wear by galling, in which localized areas of metal surfaces in contact "weld" together and particles are torn off the original surface of one or the other of the bearing parts.

In methods of guarding against wear, lubrication stands first of all. With complete and efficient lubrication wear is negligible. When lubrication is inefficient or can not be used, other means of preventing wear must be employed. Ball and roller bearings, and white metal alloy and bronze bearing metals are widely used as a second line of defense against failure of lubrication. Methods of producing very hard surfaces on relatively soft metals are case-hardening and nitriding of steel, chromium plating, and surface layer welding. For some types of service the "super hard" alloys, such as "stellite" and sintered tungsten carbide, are becoming more widely used. The hardness of these latter alloys approaches that of the diamond.

There are a number of laboratory methods applicable to the testing of the wear resistance of metals, but it is at present difficult or even impossible to translate the laboratory data into the terms of probable life of actual service.

ENDURANCE TESTING OF STEEL

The bureau is engaged in an extensive study of the properties of rail steels. One phase of the investigation is the determination of the endurance limits of this material, with the object of ascertaining, if possible, to what extent the resistance of a rail to the repeated stresses to which it is subjected in service may be related to the nonmetallic inclusions or "dirt" and other unsound conditions in the steel. To determine which method of test would be the most discriminating in showing the effects of such inclusions and other unsound conditions in the steel upon the endurance properties, comparisons were made between the rotating beam and the axial-loading methods for the determination of endurance limits.

The materials used for the comparative tests were an open-hearth iron containing 0.02 per cent carbon; wrought iron in three stages of refinement by rolling; three plain carbon steels containing 0.45, 0.47, and 0.87 per cent carbon, respectively, and each tested in both the annealed and in the heat-treated conditions; and four rail steels.

In no case was the endurance limit determined by the axial-loading method greater than that determined by the rotating-beam method. For the 0.45 per cent carbon and the 0.87 per cent carbon steels in the heat-treated condition the endurance limits were practically the same by both methods of test. The indications, in general, were that for a nonuniform material the endurance limit in axial loading is lower than it is when determined by the rotating-beam method.

HEATING VALUES OF GAS

The gas chemistry section of the bureau made a series of analyses of Washington, D. C., city gas, during the transition from carbureted water gas to a mixture of this with natural gas. In carrying out these analyses the apparatus and method reported in the American Gas Journal, April and May, 1931, were employed. Using data based upon all the analyses performed rather than upon a selected group, the agreement between the heating values calculated from the analyses and those determined by actual calorimetric measurement have been found to be very satisfactory. The average difference between calculated and observed heating values was 2 B. t. u. per cubic foot in a gas of approximately 600 B. t. u. per cubic foot.

HEAT TRANSFER IN REFRIGERATOR CABINETS

The performance of any particular refrigerator under any one condition, for example, with a room temperature of 80°, can be measured by making the necessary observations of ice meltage, temperatures inside the refrigerator, etc., and the time required will not be more than a few days. If, however, one also wishes to study the performance when the outside temperature is higher or lower than 80°, and how inside temperatures change as the ice melts, or finally, the performance of refrigerators similar, in general, to the one tested but differing from it in having more or less insulation, or in details of construction, a very large number of experiments

would have to be made. However, most of these additional experiments can be dispensed with, by making use of well-known principles of heat transfer, together with data relating to the insulating value of the materials used in the construction. In a paper by J. L. Finck and M. S. Van Dusen, which will be published in *Refrigerating Engineering*, the monthly journal of the American Society of Refrigerating Engineers, an exposition is given of the methods which may be used in making such calculations. The calculations relating to the insulating values of the walls will be of value chiefly to manufacturers who are interested in estimating the effect that changes in structural features, amount and kind of insulation, etc., may be expected to have upon the performance of their product. The effects of such changes may be calculated with about the same degree of certainty as can be attained in actual measurements and at a small fraction of the cost of building sample refrigerators and testing them. Some of the calculated results are, however, of considerable use to the owners of refrigerators. For example, a particular refrigerator having a 1-inch thickness of insulating material in the walls and which had an average inside temperature of 45° when the outside temperature was 60° would have an inside temperature of nearly 60° when the outside temperature was 90° . But another refrigerator, with exactly the same inside construction but having $2\frac{1}{2}$ inches of insulation, would have an inside temperature of 42° when the outside temperature was 60° , and if the outside temperature should rise to 60° , the inside temperature would remain below 55° .

Another calculation of interest shows how the temperature inside a refrigerator may change as the ice melts away. Thus with an outside temperature of 85° F. one refrigerator tested had an inside temperature of 52° when iced to capacity, but when the weight of ice had decreased to one-half the original the inside temperature would rise to 58° , and when three-fourths of the ice was gone the temperature would be up to 64° .

IMPROVED MERCURY MANOMETER AND PISTON GAGES FOR MEASURING PRESSURE DIFFERENCES

In power plants, steam and other substances are used as media to convert heat into mechanical power; in refrigerating plants numerous substances, such as ammonia, carbon dioxide, sul-

phur dioxide, and methyl chloride, are used to convert mechanical power into cooling effect. These media possess certain properties on which accurate data are of prime importance to the power plant and the refrigerating engineer. The acquirement of these data necessitates accurate pressure measurements. For this purpose a differential mercury manometer for pressure differences up to 15 atmospheres (about 220 lbs./in.²), and a group of piston gages for pressures up to 100 atmospheres (about 1,500 lbs./in.²) have been constructed and maintained at the bureau. These instruments will be described and their accuracy discussed in a paper to be published in the June number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH.

The manometer, instead of being constructed in the form of a single column or a single U shaped tube, consists of five U tubes connected in series; the instrument in this form is of such reduced height that it may be housed in one room. The lower halves of the U tubes are filled with mercury, the upper halves with water. A pressure applied at the left-hand end of the manometer causes a simultaneous depression of the mercury and water in the left-hand branches of the U tubes and a corresponding rise of these fluids in the right-hand branches. The applied pressure is determined by observing the positions of the various mercury surfaces and calculating the sum of the difference in heights between the surfaces in the right and those in the left hand branches. Pressures can be measured with this manometer with an accuracy of about 1 part in 10,000.

Each piston gage consists of a steel piston movable vertically inside a steel cylinder. This piston is rotated in order to reduce frictional forces which hinder the vertical movement. Oil is used to lubricate the gage and to transmit the observed pressure to the bottom of the piston. This transmitted pressure is measured by adjusting the weights supported by the piston until there is no vertical movement. The pressure may then be calculated in any desired units by multiplying the combined weight of the piston and its load by the appropriate factor. The value of this factor may be determined from the measurements of the piston diameter and the width of crevice between the piston and cylinder, in which case the gage is said to be an absolute or primary instrument; or it may be determined from a comparison of the piston gage with a mercury manome-

ter, in which case the manometer is said to be the primary instrument, and the piston gage is a secondary instrument. When used as primary instruments, the piston gages at the National Bureau of Standards are accurate to within 2 or 3 parts in 10,000; when used as secondary instruments, they are as accurate as the manometer, namely, to about 1 part in 10,000.

CHANGE IN TRANSFERENCE NUMBER OF A SALT WITH CHANGE IN CONCENTRATION

A method for determining the rate of change of the transference number of a salt with change in concentration, based on a modification of the moving boundary method, will be described in the June number of the *BUREAU OF STANDARDS JOURNAL OF RESEARCH*. Junctions between solutions of the same salt at different concentrations are formed and the volumes through which the junctions move during the passage of known amounts of electricity are measured. The changes in transference numbers between the concentrations across the junctions are calculated from these data. The method was tested for solutions of lithium, sodium, and potassium chloride. It was found that potassium chloride exhibits but little change in transference number on passing from dilute to 4.7 molal solution.

PURIFICATION AND ANALYSIS OF ALKALI CYANIDES

An alkali cyanide, such as sodium or potassium cyanide, is an essential constituent of many electroplating baths, including those for depositing silver, copper, gold, cadmium, zinc, and brass. Various methods of analysis have been employed to determine the purity of alkali cyanide. As these methods vary in accuracy, the results obtained depend on which one is used.

In a research to be described in the June number of the *BUREAU OF STANDARDS JOURNAL OF RESEARCH*, alkali cyanide of high purity was prepared in the laboratory. This material was used for checking the accuracy of several of the best-known analytical methods. While not immediately applicable to commercial plating baths, the results of this research will be of value in further investigations in this field.

RADIO TRANSMISSIONS OF STANDARD FREQUENCY

The bureau announces a new schedule of radio transmissions of standard frequencies. This service may be used

by broadcasting and other stations in adjusting their transmitters to exact frequency, and by the public in calibrating frequency standards and transmitting and receiving apparatus. The signals are transmitted from the bureau's station WWV, Washington, D. C., every Tuesday afternoon and evening. They can be heard and utilized by stations equipped for continuous-wave reception at distances up to about 1,000 miles from Washington, and some of them at all points in the United States. The time schedules are different from those used in prior transmissions.

These are two classes of transmissions provided—one, transmission of the highest accuracy at 5,000 kc. for two hours in the afternoon and two hours in the evening on three Tuesdays in each month; the other transmissions of a number of frequencies in 2-hour periods in the afternoon and evening, one Tuesday a month. The transmissions are by continuous-wave radiotelegraphy. The 5,000 kc. transmissions consist mainly of a continuous CW transmission, giving a continuous whistle in the receiving phones. The first five minutes of this transmission consist of the general call (CQ de WWV) and announcement of the frequency. The frequency and the call letters of the station (WWV) are given every 10 minutes thereafter. The transmissions of the other type are also by continuous-wave radiotelegraphy. A complete frequency transmission includes a "general call," "standard frequency signal," and "announcements." The general call is given at the beginning of each 18-minute period and continues for about 2 minutes. This includes a statement of the frequency. The standard frequency signal is a series of very long dashes with the call letters (WWV) intervening; this signal continues for about 8 minutes. The announcements follow, and contain a statement of the frequency being transmitted and of the next scheduled frequency. There is then a 6-minute interval for adjustment of the transmitting set.

Information on how to receive and utilize the signals is given in Bureau of Standards Letter Circular No. 280, which may be obtained by applying to the bureau. Even though only a few frequencies are received (or even only a single one), persons can obtain as complete a frequency meter calibration as desired by the method of generator harmonics.

The 5,000 kc. transmissions are from a transmitter of 1 kw. power; they

occur every Tuesday except the first in each month. The other transmissions are from a transmitter of one-half kw. power; they are given on the first Tuesday of every month.

5,000 kc. transmissions 2 to 4 p. m., and 10 p. m. to 12 midnight, eastern standard time

July	August	September
14 21 28	11 18 25	8 15 22 29

Multifrequency transmissions

Eastern standard time		Frequencies		
		July 7	Aug. 4	Sept. 1
p. m.	p. m.	kc.	kc.	kc.
2	10	1,400	3,600	6,400
2.18	10.18	1,800	4,000	7,000
2.36	10.36	2,000	4,400	7,600
2.54	10.54	2,400	4,800	8,200
3.12	11.12	2,800	5,200	8,800
3.30	11.30	3,200	5,600	9,400
3.48	11.48	3,600	6,400	10,000

The frequencies in the 5,000 kc transmissions are piezo controlled, and are accurate to much better than 1 part in 1,000,000. The frequencies in the multifrequency transmissions are manually controlled, and are accurate to 1 part in 100,000.

Since the start of the 5,000 kc transmissions the bureau has been receiving reports regarding the reception of these transmissions and their use for frequency measurements from nearly all parts of the United States, including the Pacific coast and Alaska. More reports on these transmissions are desired, because radio transmission phenomena change with the season of the year. The data thus far obtained cover the first six months of 1931, and give information regarding approximate field intensity, fading, and the suitability of the transmissions for frequency measurements.

It is suggested that in reporting upon the field intensity of these transmissions, the following designations be used where field intensity-measurement apparatus is not at hand: (1) Hardly perceptible, unreadable; (2) weak, readable now and then; (3) fairly good, readable with difficulty; (4) good, readable; (5) very good, perfectly readable.

A statement as to whether fading is present or not is desired, and if so, its characteristics, such as whether slow or rapid and time between peaks of signal intensity. Statements as to the type of receiving set used in reporting on the transmissions and the type of antenna used are likewise desired. The bureau would also appreciate reports on the use of the transmissions for purposes of frequency measurement or control.

Reports should be addressed to National Bureau of Standards, Washington, D. C.

NEW AND REVISED PUBLICATIONS ISSUED DURING MAY, 1931

Journal of Research¹

Bureau of Standards Journal of Research, Title page and index to volume 5, July to December, 1930 (RP Nos. 183 to 258, inclusive). Free on application to the Bureau of Standards.

Bureau of Standards Journal of Research, Vol. 6, No. 5, May, 1931 (RP Nos. 303 to 313, inclusive). Price, 40 cents. Obtainable by subscription.

Research Papers²

(Reprints from Journal of Research)

RP279. A method for the standardization of permeameters at high magnetizing forces; R. L. Sanford. Price, 5 cents.

RP280. Determination of the toluene content of a midcontinent petroleum; J. H. Bruun, R. T. Leslie, and S. T. Schickanz. Price, 5 cents.

RP281. Mechanism of the atomization of liquids; R. A. Castleman, jr. Price, 5 cents.

RP282. Separation of normal octane from petroleum by distillation and crystallization; R. T. Leslie and S. T. Schickanz. Price, 10 cents.

RP283. Further measurements of propeller fan characteristics; P. S. Ballif and H. L. Dryden. Price, 10 cents.

RP284. A precision cryostat with automatic temperature regulation; R. B. Scott and F. G. Brickwedde. Price, 5 cents.

RP285. The paper-making properties of phormium tenax (New Zealand flax); M. B. Shaw, G. W. Bicking, and M. J. O'Leary. Price, 10 cents.

RP286. A method for the separation and gravimetric determination of osmium; R. Gilchrist. Price, 10 cents.

See footnote 2 on p. 70.

RP287. Application of the fluorating process to fructose; D. H. Brauns and H. L. Frush. Price, 5 cents.

RP288. Moisture expansion of glazes and other ceramic finishes; H. G. Schurecht and G. R. Pole. Price, 5 cents.

RP289. Extension of the standard visibility function to intervals of 1 millimicron by third-difference osculatory interpolation; D. B. Judd. Price, 5 cents.

RP290. Durability and strength of bond between mortar and brick; L. A. Palmer and J. V. Hall. Price, 10 cents.

RP291. Heat transfer through building walls; M. S. Van Dusen and J. L. Finck. Price, 15 cents.

*Simplified Practice Recommendations*²

R118-30. Abrasive grain size. Price, 5 cents.

*Commercial Standards*²

CS14-31. Boys' blouses, button-on waists, shirts, and junior shirts. Price, 5 cents.

*Commercial Standards Monthly*²

Commercial Standards Monthly, Vol. 7, No. 11; May, 1931. Price, 10 cents. Obtainable by subscription.

*Technical News Bulletin*²

Technical News Bulletin No. 169, May, 1931. Price, 5 cents. Obtainable by subscription.

LETTER CIRCULARS PREPARED DURING MAY, 1931²

LC302. Battery compounds and solutions.

LC303. Sound absorption coefficients of the more common materials. (Supersedes LC293.)

² Send orders for publications under this heading with remittance only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 40 cents. Subscription to Journal of Research, \$2.75 per year; other countries, \$3.50. Subscription to Commercial Standards Monthly, \$1 per year; other countries, \$1.25.

³ "Letter circulars" are in mimeographed form and are designed primarily to answer specific inquiries. The supply is necessarily limited so that in general but one copy can be sent in answer to each request. Copies are available only on application to the National Bureau of Standards, Washington, D. C. No mailing list is maintained for "letter circulars," and complete sets of back numbers can not be furnished.

LC304. Painting plaster.

LC305. A guide to the literature on rubber.

OUTSIDE PUBLICATIONS⁴

"What is a 50-pound weight?" involves intricate problems. R. W. Smith; United States Daily (Washington, D. C.), Vol. VI, No. 64, p. 4; May 16, 1931.

Thermal expansion of M-M-M Alloy. Peter Hidnert and W. T. Sweeney; Physical Review (Corning, N. Y.), Vol. 36, p. 787; Aug. 15, 1930.

Die Dosierungseinheit bei der ultraviolett-therapie. W. W. Coblenz; Strahlentherapie (Urban & Schwarzenberg, Berlin, Germany), Vol. 39, p. 515; 1931.

Some common errors of gas analysis and their remedies. Martin Shepherd; American Gas Journal (New York, N. Y.), Vol. 134, p. 49; April, 1931.

Recommended specifications for analytical reagent chemicals. W. D. Collins, G. P. Baxter, H. V. Farr, J. V. Freeman, Joseph Rosin, G. C. Spencer, and Edward Wichers; Industrial and Engineering Chemistry (Washington, D. C.), Analytical edition, Vol. 3, p. 221; April 15, 1931.

Beitrag zur berechnung der kontraktionszahl. Edgar Buckingham; Forschung (Verein Deutscher Ingenieure, Berlin, Germany), Vol. 2, No. 5, p. 185; May, 1931.

Work is started upon laboratory for hydraulics. H. N. Eaton; United States Daily (Washington, D. C.), Vol. VI, No. 63, p. 3; May 15, 1931.

Moisture expansion of glazes and other ceramic finishes. H. G. Schurecht and G. R. Pole; Journal, American Ceramic Society (Columbus, Ohio), Vol. 14, No. 4, p. 313; April, 1931.

The Government in ceramics. Ceramic division staff; Ceramic Age (Newark, N. J.), Vol. 17, No. 5, p. 260; May, 1931.

Exchange of ideas is urged to reduce waste in industry. E. W. Ely; United States Daily (Washington, D. C.), Vol. VI, No. 58, p. 9; May 9, 1931.

Review of "The Organization of Knowledge and the System of the Sciences," by Henry Evelyn Bliss. Paul R. Heyl; Science (New York, N. Y.), Vol. 73, No. 1897, p. 498; May 8, 1931.

⁴ "Outside publications" are not for distribution or sale by the Government. Requests should be sent direct to publishers.

Federal bureau seeks answer to new problems in industry. George K. Burgess; United States Daily (Washington, D. C.), Vol. VI, No. 62, p. 1; May 14, 1931.

Recent work of the Bureau of Standards. George K. Burgess, the Military Engineer (Washington, D. C.), Vol. XXIII, No. 129, p. 208; May-June, 1931.

Technical news items are published in this Bulletin. The items are selected from the technical literature and are intended to provide a summary of the latest developments in the field of technical science. The items are arranged in alphabetical order of the author's name. The items are published in the Bulletin in the form of short articles or abstracts. The items are published in the Bulletin in the form of short articles or abstracts.

